

Application/Control Number: 10/784,981
Art Unit: 1713

Remarks

The Examiner's comments and objections and the cited references have been carefully considered by the Applicant.

Claims 3 and 11-14 are amended and new claims 15-17 are hereby submitted.

Claim 3 is amended to cancel the wording "preferably 70-80%", claims 11-14 are amended to correctly depend on claim 5, new claim 15 is supported by original claim 3, new claim 16 is supported by original claims 1 and 3 and new claim 17 is supported by original claim 1 and the original description page 3, lines 27-29.

Before addressing the Examiner's objections, it may be useful to outline the following:

The problem addressed by the present invention is that of overcoming problems encountered for known thermosetting composite materials comprising a resin matrix and quartz particles and the solution to this problem offered by the invention is a thermosetting composite material comprising a polymeric matrix and glass particles with a specified particle size distribution (original application, page 1, line 10 to page 3, line 11).

Claim Objections

The use of the phrase "preferably" is considered by the Examiner to render the claim 3 to be vague. Claim 3 amended to cancel the phrase "preferably 70-80%", thereby the claim objection is considered to be overcome.

Claim Rejection - 35 USC § 112

Claims 11-14 are rejected because there is insufficient antecedent basis for the limitation "said syrup" and "with respect to said syrup". Claims 11-14 are amended to depend on claim 5 that mentions "a syrup", thereby an antecedent basis for such limitations exists.

It is considered that the claims 11-14 particularly point out and distinctly claim the subject matter which the applicant regards as the invention.

Claim Rejections - 35 USC § 102

Claims 1-5, 8, 10 and 11 are rejected as being anticipated by Schock (US005218013A).

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However, to anticipate a claim, a reference must teach every element of the claim (MPEP§2131).

In this regard the Applicants note that:

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference"

(Verdegaal Bros. V. Union Oil Co. Of California, 814 F.2d 628, 631, 2 USPQ2d 1051 (Fed.Cir. 1087)).

Claim 1 requests the claimed material to incorporate a filler material constituted by glass particles while Schock never discloses a material comprising glass particles, neither expressly nor inherently.

The Examiner states that "Schock discloses the filler to be crystalline quartz sand as well as mineral fillers. It is well known in the art that the glass is made of the same elements of crystalline quartz sand as well as mineral fillers. Therefore, the fillers of Schock would also be glass particle fillers." No documentary proof is produced by the Examiner in support of this position.

In this regard the Applicant notes that:

"To serve as an anticipation when the reference is silent about the asserted inherent characteristic, such gap in the reference may be filled with recourse to extrinsic evidence. Such evidence must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by a person of ordinary skill."
(Continental Can Co. USA v. Monsanto Co., 948 F.2d 1264, 1268, 20 USPQ2d 1746, 1749 (Fed. Cir. 1991)).

The Applicants respectfully traverse the Examiner's assertion and submits that one of ordinary skill in the art would not have known that "crystalline quartz sand" meant glass.

Moreover, the Applicants submit that not only the knowledge that "crystalline quartz sand" meant glass is not notorious, but on the contrary, the skilled person knew that crystalline quartz sand and glass are different materials with different properties. In fact, the crystalline quartz sand is a crystalline naturally occurring material while glass is an amorphous material obtained with a technological process and having different properties with respect to the used raw materials. Definitions of quartz and glass, clearly showing that they are different materials, can be found in manuals and encyclopedias. As an example, definitions given in the Encyclopedic Scientific and Technical Dictionary, McGraw Hill, Zanichelli, pages 637 and 1212, are herewith enclosed. In addition, a warning regarding the possible misinterpretation of quartz and glass is given in Encyclopedia of Chemical Technology, Kirk-Othmer, second completely revised edition, Vol. 18, page 75, herewith enclosed. Furthermore, Schock explicitly states that "The mineral filler particles .. that are to be used as fillers in accordance with the invention can be obtained extremely cheaply as a natural product since crystalline quartz sand is a by-product of kaolin extraction." This is clearly

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not the case for glass.

At least for this reason claim 1 is not anticipated by Schock.

It is accordingly considered that the subject matter of claim 1 is novel over Schock, as well as the subject matter of claims 2-5, 8, 10 e 11 depending thereon.

Claim Rejections – 35 USC § 103

It is moreover submitted that the claimed subject matter could not have been derived by the skilled person in an obvious manner from the teachings of the references of record, when considered individually or in any combination.

To establish obviousness the Examiner must proffer an objective showing that would lead the one of ordinary skill to the claimed subject matter. In this regard, the Applicants note that:

The criterion for determination of obviousness is whether the prior art would have suggested to one of ordinary skill in the art that this process should be carried out and would have a reasonable likelihood of success, viewed in the light of the prior art... Both the suggestion and the expectation of success must be found in the prior art, not in the applicant's disclosure.

In re Dow Chemical, 837 F.2d 469, 473, 5 USPQ2d 1529, 1531 (Fed. Cir. 1988)

Here, the Examiner has not identified any objective suggestion in the cited art to modify the material of Schock as required by the claims. For this reason alone, the rejection should be withdrawn. Even if, as the Examiner alleges, Schock discloses a resin forming a matrix and a filler comprised, at least predominantly, of quartz particles, the majority of the quartz particles having a size of between 0.1 mm and 2 mm, Schock does not teach or suggest a composite material comprising glass particles. There is no motivation use glass particles.

In view of the above, the Applicants submit that the claimed subject matter as a whole would not have been obvious at the time the invention was made to a person having ordinary skill in the art.

Moreover, the Applicants have found that the claimed material, that comprises glass particles, has improved properties with regard to the resistance to staining and bacterial proliferation with respect the composite material comprising quartz, even after a long period of use, when glass particles are possibly no more protected by the resin layer, while the composite material comprising quartz particles, after a long period of use when the quartz particles are no more coated with resin, becomes stained and

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allows the proliferation of microorganisms. Moreover, problems encountered when quartz is used are already shown in the original application pages 1 and 2 and the beneficial properties of the claimed material comprising glass particles are already shown in the original application, pages 2 and 3.

In view of the foregoing, favorable action on the merits, including entry and approval of all amendments, reconsideration and withdrawal of each rejection and allowance of all claims is respectfully solicited.

Respectfully submitted,


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Encl.: Dizionario Enciclopedico Scientifico e Tecnico ZANICHELLI,
Pages 637 and 1212;
Encyclopedia of Chemical Technology, Kirk-Othmer, Page 75.

IL MCGRAW-HILL ZANICHELLI

small size

DIZIONARIO ENCICLOPEDICO
SCIENTIFICO E TECNICO
INGLESE-ITALIANO
ITALIANO-INGLESE

*edizione facsimile
ridotta fotograficamente*



ZANICHELLI

- 637 -
glass lase

acial striae [GBOL] *striazioni glaciali* Scratches, commonly parallel, on smooth rock surfaces due to glacial abrasion.

acial till - V. till.

acial varve - V. varve.

aciated terrain [GBOL] *terreno affetto da glaciazione* A region that once bore great masses of glacial ice; a distinguishing feature is marks of glaciation.

aciation *glaciazione* [GBOL] Alteration of any part of the earth's surface by passage of a glacier, chiefly by glacial erosion or deposition. [METEOR] The transformation of cloud particles from waterdrops to ice crystals, as in the upper portion of a cumulonimbus cloud.

aciation limit [GEOPIS] *limite di glaciazione* For a given locality, the lowest altitude at which glaciers can develop.

acier [IDROL] *ghiacciaio* A mass of land ice, formed by the further recrystallization of firn, flowing slowly (at present or in the past) from an accumulation area to an area of ablation.

acreret - V. snowdrift ice.

acier flow [IDROL] *moto del ghiacciaio* The motion that exists within a glacier's body. Also known as glacial flow.

acier front [IDROL] *fronte del ghiacciaio* The leading edge of a glacier.

acier ice [IDROL] *ghiaccio di ghiacciaio* Any ice that is or was once a part of a glacier, consolidated from firn by further melting and refreezing and by static pressure; for example, an iceberg.

acier mill - V. moulin.

acier pothole - V. moulin.

acier table [GBOL] *blocco di roccia in un ghiacciaio* A stone block supported by an ice pedestal above the surface of a glacier.

acier well - V. moulin.

acier wind [METEOR] *vento di ghiacciaio* A shallow gravity wind along the icy surface of a glacier, caused by the temperature difference between the air in contact with the glacier and free air at the same altitude.

glacioluvial [GBOL] *glacioluviale* Pertaining to streams fed by melting glaciers, or to the deposits and landforms produced by such streams.

glaciolacustrine [GBOL] *glaciolacustre* Pertaining to lakes fed by melting glaciers, or to the deposits forming therein.

glaciology [GBOL] *glaciologia* The study of existing or modern glaciers in their entirety.

glacçon [OCEANOGR] *frammento di ghiaccio galleggiante* A piece of sea ice which is smaller than a medium-sized floe.

gladlate [BOT] *gladiato* Sword-shaped.

gladiolus - V. mesosternum.

● Gladiolus [BOT] ⇔ A genus of chiefly African plants in the family Iridaceae having erect, sword-shaped leaves and spikes of brightly colored irregular flowers.

gladite [MINERAL] ⇔ $PbCuBiS_8$ A lead gray mineral consisting of lead and copper bismuth sulfide; occurs as prismatic crystals.

Gladstone-Dale law [OTTICA] *formula di Gladstone-Dale* A law for the variation of the index of refraction n of a substance, according to which $n - 1$ is proportional to its density.

glance pitch [OSOL] *carbone glance pitch* A variety of asphaltite having brilliant conchoidal fracture, and resembling gilsonite but having higher specific gravity and percentage of fixed carbon.

glancing angle [FIS] *angolo di incidenza* The angle between a surface and a beam of particles or radiation incident upon it; it is the complement of the angle of incidence.

gland [ANAT] *ghiandola* A structure which produces a substance essential and vital to the existence of the organism. [ING] *premitoppa* 1. A device for preventing leakage at a machine joint, as where a shaft emerges from a vessel containing a pressurized fluid. 2. A movable part used in a stuffing box to compress the packing.

glanders [VETER] *morva; farcino* A bacterial disease of equines caused by *Actinobacillus mallei*; involves the respiratory system, skin, and lymphatics. Also known as farcy.

glands of Brunner - V. Brunner's glands.

glands of Leydig [ZOOLOG] *ghiandola di Leydig* Unicellular, epididymal structures of urodele larvae and the adult *Necturus* that secrete a substance which digests the egg capsule and permits hatching.

glandular fever - V. infectious mononucleosis.

glandulomuscular [ANAT] *mioghiandolare* Of or pertaining to glands and muscles.

glans [ANAT] *glande* The conical body forming the distal end of the clitoris or penis.

glare [OTTICA] *abbagliamento* 1. Discomfort produced in an observer by one or more visible sources of light. Also known as discomfort glare. 2. Visual disability caused by visible sources or areas of luminance which are in an observer's field of view but are not sources in vision. Also known as disability glare. 3.

Dazzling brightness of the atmosphere, caused by excessive reflection and scattering of light by particles in the line of sight.

glare ice [IDROL] *ghiaccio liscio* Ice with a smooth, shiny surface.

Glareolidae [ZOOLOG] ⇔ A family of birds in the order Charadriiformes including the ploverlike coursers and the swallowlike pratincoles.

glareous [ECOL] *specie da ghiala* Growing in gravelly soil; refers specifically to plants.

glaserite - V. arcanite.

glass [MATER] *vetro* A hard, amorphous, inorganic, usually transparent, brittle substance made by fusing silicates, sometimes borates and phosphates, with certain basic oxides and then rapidly cooling to prevent crystallization. [METEOR] ⇔ (*lett. vetro*) In nautical terminology, a contraction for "weather glass" (a mercury barometer).

glass armor [MIL] *corazzatura in vetro; vetro corazzato* Any of several special-purpose protective barrier materials composed of glass or containing glass.

glassblowing [ING] *soffiatura del vetro* Shaping a mass of viscous glass by inflating it with air introduced through a tube.

glass-bonded mica [MATER] *mica agglomerata con vetro* An insulating material made by compressing a mixture of powdered glass and powdered natural or synthetic mica at high temperatures.

glass brick [MATER] *mattoni di vetro* A hollow block of translucent glass with patterns molded on the faces; used in partitions.

glass capacitor [ELETTR] *condensatore con dielettrico di vetro* A capacitor whose dielectric material is glass.

glass cutter [ING] *tagliavetro* A tool equipped with a steel wheel or a diamond point used to cut glass.

glass dosimeter [ING NUCL] *dosimetro a piastra di vetro fluorescente* A dosimeter using as its radiation-sensing element a fluorid of special glass that fluoresces under ultraviolet light following gamma irradiation.

glassed steel [ING CHIM] *acciaio rivestito di vetro* Process piping or vessels lined with glass; a glass-steel composite has structural strength of steel and corrosion resistance of glass.

● glass electrode [CHIM FIS] *elettrodo a vetro* An electrode or half cell in which potential measurements are made through a glass membrane, which acts as a cation-exchange membrane; thus, the potential arises from phase-boundary and diffusion potentials which, depending on the composition of the glass, are logarithmic functions of the activity of the cations such as H^+ , Na^+ , or K^+ of the solutions in which the electrode is immersed.

Glasser's disease [VETER] *malattia di Glasser* A generalized bacterial infection of swine caused by *Mycoplasma hyorhinis*.

glass fiber [MATER] *fibra di vetro* A glass thread less than a thousandth of an inch (25 micrometers) thick, used loosely or in woven form as an acoustic, electrical, or thermal insulating material and as a reinforcing material in laminated plastics.

glass film plates [GRAF] *lastre fotografiche di vetro* Film plates made of glass sheets coated with a sensitized emulsion; they have been largely replaced by sheet film, but are still used in some critical work because of their dimensional stability.

glass fission detector [ING NUCL] *rivelatore di fissione a vetro* A piece of glass in which fission fragments, flying apart with high energy, can create narrow but continuous, submicroscopic trails of altered material, which can be seen in an ordinary microscope after the altered material has been dissolved by a chemical reagent.

glass furnace [ING] *forno da vetro* A large, covered furnace or tank for melting large batches of glass, in which heat is supplied by a flame playing over the glass surface, and regenerative heating of combustion air and gas is usually employed. Also known as glass tank.

glass guide [GRAF] *guida di vetro* In microfilm photography, a transparent bar of optical glass employed to guide documents through the photographic field.

glass heat exchanger [ING] *scambiatore di calore di vetro* Any heat exchanger in which glass replaces metal, such as shell-and-tube, cascade, double-pipe, bayonet, and coil exchangers.

glassine [MATER] *pergamina sottile; p. trasparente* A thin, dense, transparent, supercalendered paper from highly refined sulfite pulp, used for envelope windows, for sanitary wrapping, and as an insulating paper between layers of iron-core transformer windings.

glass insulator [MATER] *isolatore di vetro* An insulator for a power transmission line made of annealed or toughened (tempered) glass.

glassivation [ELETTRON] *passivazione con vetro* Method of transistor passivation by a pyrolytic glass-deposition technique, whereby silicon semiconductor devices, complete with metal contact systems, are fully encapsulated in glass.

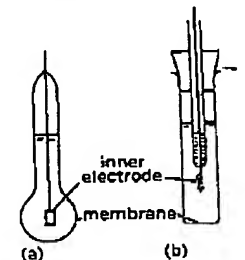
glass laser [OTTICA] *laser a vetri* A solid laser in which glass serves as the host for laser ions of such materials as erbium, holmium, neodymium, and ytterbium. Also known as

GLADIOLUS



A specimen of the genus *Gladiolus* showing the erect sword-shaped leaves and spike of flowers.

GLASS ELECTRODE



Two types of glass electrode: (a) bulb type; (b) flat-membrane type.

quantum theory of radiation [MECC QUANT] 1. *teoria quantistica della radiazione* The theory of heat radiation based on Planck's law; its principal result is the Planck radiation formula. 2. - *V.* quantum electrodynamics.

quantum theory of spectra [MECC QUANT] *teoria quantistica degli spettri* The contemporary theory of spectra, based on the idea that an atom, molecule, or nucleus can exist only in certain allowed energy states, that it emits or absorbs energy as it changes from one state to another, and that the frequency of the associated electromagnetic radiation equals the difference in energies of two states divided by Planck's constant.

quantum theory of valence [CHIM FIS] *teoria quantistica della valenza* The theory of valence based on quantum mechanics; it accounts for many experimental facts, explains the stability of a chemical bond, and allows the correlation and prediction of many different properties of molecules not possible in earlier theories.

quantum-wave equation [MECC QUANT] *equazione quantistica delle onde* A partial differential equation which relates the spatial and time dependences of the wave function of a system of one or more atomic or subatomic particles; examples are the Schrödinger equation in nonrelativistic quantum mechanics, and the Klein-Gordon, Dirac, Rarita-Schwinger and Proca equations in relativistic quantum mechanics.

quantum yield [CHIM FIS] *rendimento quantico* For a photochemical reaction, the number of moles of a stated reactant disappearing, or the number of moles of a stated product produced, per einstein of light of the stated wavelength absorbed.

quadrilateral [GEOLOG] *struttura periclinal* Of strata and geologic structures, dipping outward in all directions away from a central point.

quarantine [MED] *quarantena* Limitation of freedom of movement of susceptible individuals who have been exposed to communicable disease, for a period of time equal to the incubation period of the disease.

quarantine anchorage [ING CIV] *ancoraggio di quarantena* An area where a vessel anchors when satisfying quarantine regulations.

quarantine buoy [NAVIC] *boa gialla di posto di quarantena* A buoy marking the location of a quarantine anchorage.

quark [FIS SUBNUCL] \bar{q} One of the hypothetical basic particles, having charges whose magnitudes are $\frac{1}{3}$ or $\frac{2}{3}$ of the electron charge, from which many of the elementary particles may, in theory, be built up; for example, nucleons may be formed from three quarks and mesons from quark-antiquark combinations; no experimental evidence for the actual existence of free quarks has been found.

quarry [ING CIV] *cava* An open or surface working or excavation for the extraction of building stone, ore, coal, gravel, or minerals.

quarry bar [ING CIV] *barra di guida per tagliablocchi* A horizontal bar with legs at each end, used to carry machine drills.

quarry face [ING MIN] *pietra da costruzione in blocchi grezzi* The freshly split face of ashlar, squared off for the joints only and used for massive work.

quarrying [ING CIV] *coltivazione a giorno* The surface exploitation and removal of stone or mineral deposits from the earth's crust. [GEOLOG] - *V.* plucking.

quarrying machine [ING MECC] *carro di perforazione* Any machine used to drill holes or cut tunnels in native rock, such as a gang drill or tunneling machine; most commonly, a small locomotive bearing rock-drilling equipment operating on a track.

quarry powder [MATER] *polvere da mina* Ammonium nitrate dynamites used in quarrying where blasts of several tons of explosives are needed.

quart [MECC] \bar{q} Abbreviated qt. 1. A unit of volume used for measurement of liquid substances in the United States, equal to 2 pints, or $\frac{1}{4}$ gallon, or 57 $\frac{1}{2}$ cubic inches, or $9.46352946 \times 10^{-4}$ cubic meter. 2. A unit of volume used for measurement of solid substances in the United States, equal to 2 dry pints, or $\frac{1}{2}$ bushel, or 107,521/1,600 cubic inches, or approximately 1.10122×10^{-3} cubic meter. 3. A unit of volume used for measurement of both liquid and solid substances, although mainly the former, in the United Kingdom, equal to 2 U.K. pints, or $\frac{1}{4}$ U.K. gallon, or approximately 1.13652×10^{-3} cubic meter.

quarter [MECC] \bar{q} 1. A unit of mass in use in the United States, equal to $\frac{1}{4}$ short ton, or 500 pounds, or 226.796185 kilograms. 2. A unit of mass in troy measure, equal to $\frac{1}{4}$ troy hundredweight, or 25 troy pounds, or 9.33104304 kilograms. Abbreviated qr tr. 3. A unit of mass used in the United Kingdom, equal to $\frac{1}{4}$ hundredweight, or 28 pounds, or 12.70058636 kilograms. Abbreviated qr. 4. A unit of volume used in the United Kingdom for measurement of liquid and solid substances, equal to 8 bushels, or 64 gallons, or approximately 0.290950 cubic meter. [ARCH NAV] *anca; giardinetto* Portions of a vessel's sides about midway between the stem and the middle and between the middle and the stern.

quarter deck [ARCH NAV] *cassero* The after portion of a

weather deck.

quartering sea [NAVIC] *mare all'anca; m. al giardinetto* Waves moving in a direction approximately 45° from a vessel's heading, striking the vessel on the quarter.

quaternary phase-shift keying [ELETTRON] *modulazione a quattro fasi* Modulation of a microwave carrier with two parallel streams of nonreturn-to-zero data in such a way that the data is transmitted as 90° phase shifts of the carrier; this gives twice the message channel capacity of binary phase-shift keying in the same bandwidth. Abbreviated QPSK.

quarter-phase - *V.* two-phase.

quarter-sawn [MATER] *quarto* The grain pattern that is produced when hardwood is cut so that the annual rings are at an angle of 45° or less with the board's surface.

quarter-square multiplier [ELAB] *moltiplicatore quarter-square* A device used to carry out function multiplication in an analog computer by implementing the algebraic identity $xy = ((x + y)^2 - (x - y)^2)/4$.

quarter-turn drive [ING MECC] *trasmissione a cinghia fra assi ortogonali* A belt drive connecting pulleys whose axes are at right angles.

quarter-wave [ELETTRON] *quarto d'onda* Having an electrical length of one quarter-wavelength.

quarter-wave antenna [ELETTRON] *antenna a quarto d'onda* An antenna whose electrical length is equal to one quarter-wavelength of the signal to be transmitted or received.

quarter-wave attenuator [ELETTRON] *attenuatore a quarto d'onda* Arrangement of two wire gratings, spaced an odd number of quarter-wavelengths apart in a waveguide, used to attenuate waves traveling through in one direction.

quarter-wave line - *V.* quarter-wave stub.

quarter-wave matching section - *V.* quarter-wave transformer.

quarter-wave plate [OTTICA] *lamina quarto d'onda* A thin sheet of mica or other doubly refracting crystal material of such thickness as to introduce a phase difference of one quarter-cycle between the ordinary and the extraordinary components of light passing through; such a plate converts circularly polarized light into plane-polarized light.

quarter-wave stub [ELETTRON] *linea a quarto d'onda; tronco a quarto d'onda* A section of transmission line that is one quarter-wavelength long at the fundamental frequency being transmitted; when shorted at the far end, it has a high impedance at the fundamental frequency and all odd harmonics, and a low impedance for all even harmonics. Also known as quarter-wave line; quarter-wave transmission line.

quarter-wave termination [ELETTRON] *terminazione a quarto d'onda* Metal plate and a wire grating spaced about $\frac{1}{4}$ of a wavelength apart in a waveguide, with the plate serving as the termination of the guide; waves reflected from the metal plate are canceled by waves reflected from the grating so that all energy is absorbed (none is reflected) by the quarter-wave termination.

quarter-wave transformer [ELETTRON] *trasformatore in quarto d'onda* A section of transmission line approximately one quarter-wavelength long, used for matching a transmission line to an antenna or load. Also known as quarter-wave matching section.

quarter-wave transmission line - *V.* quarter-wave stub.

quartic - *V.* biquadratic.

quartic equation [MAT] *equazione di quarto grado; e. quartica* Any fourth-degree polynomial equation. Also known as biquadratic equation.

quartz [MINERAL] *quarzo* SiO_2 A colorless, transparent rock-forming mineral with vitreous luster, crystallizing in the trigonal prismatic class of the rhombohedral subsystem; hardness is 7 on Mohs scale, and specific gravity is 2.65; the most abundant and widespread of all minerals.

quartzarenite [PETROLOG] *arenite quarzifera* A quartz-rich sandstone with framework grains separated predominantly by cement rather than matrix; essentially an orthoquartzite.

quartz basalt [PETROLOG] *basalto quarzifero* An igneous rock with more than 5% quartz.

quartz-bearing diorite - *V.* quartz diorite.

quartz claim [ING MIN] *concessione mineraria avente per oggetto un filone* In the United States, a mining claim containing ore in veins or lodes, as contrasted with placer claims carrying mineral, usually gold, in alluvium.

quartz clock [CRONOM] *orologio a quarzo* A clock using the piezoelectric property of a quartz crystal, in which the crystal is introduced into an oscillating electric circuit having a frequency nearly equal to the natural frequency of vibration of the crystal.

quartz crystal [ELETTRON] *cristallo di quarzo; quarzo piezoelettrico* A natural or artificially grown piezoelectric crystal composed of silicon dioxide, from which thin slabs or plates are carefully cut and ground to serve as a crystal plate. [MINERAL] - *V.* rock crystal.

quartz-crystal filter [ELETTRON] *filtro a cristallo di quarzo* A filter

QUARTZ



5 cm

Quartz crystal with
o, found in Florissant,
A. (American Museum
of Natural History Specimen)

Kirk-Othmer

ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY

Second completely revised edition

VOLUME 18

Shale Oil
to
Steroids

Fused Silica should apply to any form of vitreous silica manufactured by fusion. However, it has been used by some to denote all vitreous silica not produced by quartz fusion and by others for only the translucent vitreous silica.

Synthetic Fused Silica is a term used to describe the material formed by vapor-phase hydrolysis.

Fused Quartz is the material formed by direct melting of quartz crystals. This term is used by some to denote all forms of vitreous silica and by others to specify all transparent vitreous silica.

Quartz Glass is the same as fused quartz but is ambiguous since quartz is crystalline and glass is vitreous.

Quartz is a crystalline form of silica. This much-abused term for designation of vitreous silica is absolutely incorrect.

The words transparent, nontransparent, or translucent sometimes precede the above terms to further describe the material.

Occurrence in Nature. There are a number of cases where vitreous silica occurs as the result of natural phenomena (18). A bolt of lightning can fuse quartz sand at a temperature high enough to give glass tubes called fulgurites. The best-known deposit of this type of vitreous silica, the mineral lechatelierite, is in the Libyan desert.

Deposits of natural fused quartz have also been found near Canyon Diablo, Arizona, and in small meteorite craters in Australia and Arabia. There is an uncertainty about their origin, but the most accepted theory is that pressure, created at the moment of meteorite impact, caused adiabatic instantaneous heating of sandstone to well above the quartz melting point.

As an interesting modification of this theory, Skinner and Fahey (19) propose that impact pressure creates stishovite, a crystalline form of SiO_2 with Si in sixfold coordination, which transforms to a glass with sixfold-coordinated Si. This dense glass then converts to the observed fourfold-coordinated silica glass. The process can take place in a matter of 14 min at 400°C and in 1-2 min at 800°C .

Manufacture

Nontransparent Vitreous Silica is produced by fusion of high-purity quartz sand crystals. One method is to place a charge of sand around a strong, conducting graphite rod through which a current is passed. The fusion product thus formed is plastic and can be blown into molds, drawn into tubing, or shaped by rolling or pressing. Separation from the graphite rod is facilitated by gaseous products formed by interfacial reaction. Since the outside surface is sandy, the product is known as sand-surface ware. A mat finish may be obtained by mechanical buffing, and a glazed surface can be produced by use of an electric carbon arc or flame to quickly fuse the outside surface, producing a product called glazed ware. Drawn tubing with the glazed surface is called satin tubing due to the appearance caused by the striated bubbles (10).

The Rotosil (Amersil, Inc.) process employed by Heraeus and Amersil is used for the production of tubular or cylindrical shapes and permits greater uniformity and dimensional control than the older process. The quartz sand is washed in hydrofluoric acid and distilled water. Silica is soluble in hydrofluoric acid (see under Chemical properties, p. 82) so that washing in hydrofluoric acid strips away the surface layer along with any attached impurities. Purity is extremely important, not only because im-

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